Amendments to the Specification:

Paragraph beginning on page 1, line 12

A1

In recent years, the world has witnessed explosive growth in the demand for wireless communications and it is predicted that this demand will increase in the future. There are already over 500 million users subscribing to cellular telephone services and the number is continually increasing. Eventually, in the not too distant future the number of cellular subscribers will exceed the number of fixed line telephone installations. Already, in ~~may~~ many cases, the revenues from mobile services already exceeds that for fixed line services even though the amount of traffic generated through mobile phones is much less than in fixed networks.

Paragraph beginning on page 1, line 30

A2

Most communication systems must combat a problem known as Intersymbol Interference (ISI). Ideally, a transmitted symbol ~~should arrive~~ arrives at the receiver undistorted, ~~possibly~~ attenuated ~~greatly~~ from its original magnitude and occupying only its time interval. In reality, however, this is rarely the case and the received symbols are subject to ISI. Intersymbol interference occurs when one symbol is distorted sufficiently that ~~is~~ it occupies time intervals of other symbols.

Paragraph beginning on page 2, line 3

A3

A diagram illustrating a transmitted symbol spread across multiple symbol times due to the effects of multipath propagation and filtering is shown in Figure 1. The graph depicts the received channel impulse response. It illustrates the output signal strength of the channel when only one symbol was transmitted. The ticks along the x-axis define symbol duration times T. A symbol transmitted between times 4 to 5 is spread over eight symbol times.

Paragraph beginning on page 2, line 12

A4 cont

~~Considering~~ When considering ISI caused by the radio channel, multipath fading is the primary component. The problem stems from the fact that the transmitted signal takes alternate paths in addition to the direct path. In some cases, there is no direct path because it is blocked. Each path is characterized by a different delay and reflection coefficient. The fading phenomenon is due to interference between many signal reflections each having different phases. Since the carrier frequency is typically very high in mobile radio ~~system~~ systems, any change in the propagation channel greatly affects the interference pattern. This is typically observed as fast channel variations over time. It may be characterized through Doppler spread measurements. Doppler spread is caused by the relative motion between a receiver and a transmitter. Signals arrive at the ~~receive~~ receiver

A4 cont'd

having different frequencies, amplitudes and phase. ISI can also be generated when a signal is passed through a filter too narrow to accommodate the bandwidth of the signal, e.g., the transmitter pulse shaping filter or receive filter. A narrow filter spreads the modulation pulses over time and the channel itself has filter like effects on the transmitted signal. With the radio channel, however, the characteristics of its filter like action vary with time.

Paragraph beginning on page 3, line 7

A5

There exist other equalization techniques such as Decision Feedback Equalization (DFE) or linear equalization. ~~All these~~ These equalization techniques, however, require precise knowledge of channel.

Paragraph beginning on page 3, line 17

A6

The training ~~sequences comprise sequences~~ sequence comprises a sequence of symbols generated so as to yield good autocorrelation properties. The receiver control algorithm uses the training sequence, received in the presence of ISI, to determine the characteristics of the channel that would have generated the symbols actually received. GSM uses eight different training sequences whereby the autocorrelation of each results in a central peak surrounded by zeros. The channel impulse response can be measured by correlating the stored training sequence with the received sequence.

Paragraph beginning on page 5, line 13

A7

Another disadvantage is that when the channel is longer than the estimated channel length some channel taps will be omitted when they should not be. In this case, the MLSE equalizer will not be able to eliminate the intersymbol interference completely since the entire channel impulse response is not ~~being~~ modeled.

Paragraph beginning on page 6, line 26

A8

The operation of the invention is based on selecting those taps having a larger energy ~~that~~ than the energy of the tap estimation error. This is achieved by generating a sufficiently long, initial channel estimate followed by tap energy averaging with leakage. In accordance with the invention, the energy (rather than the amplitude) of the taps is averaged ~~rather than the amplitude~~. This is critical in the case of complex channels with zero-mean taps. The initial long channel estimate enables an accurate channel order selection.

Paragraph beginning on page 7, line 1

A10

The invention provides the following advantages and benefits. First, the performance of the equalizer, especially [[a]] an MLSE based one, is enhanced by selecting the appropriate channel order. Second, the invention is well suited for random, zero-mean time varying channels such as wireless channels having blocked line of sight, including cellular, cordless, etc. Third, the invention is well suited for random, non zero-mean time varying channels such as wireless channels with line of sight, including cellular, cordless, etc.

Paragraph beginning on page 7, line 15

A11

The energy contained in the estimated channel taps is then calculated and then averaged with leakage. Averaging with leakage serves to track slow variations in the pattern of resultant channel taps. In addition, averaging of the energy, as opposed to the amplitude, is preferable since the average of the complex amplitudes of the channel taps may be zero. This is due to the fact the channel taps are represented as zero-mean, complex, Gaussian random ~~process~~ processes.

Paragraph beginning on page 10, line 12

A12

For illustration purposes, the invention is described in the context of a GSM mobile station. Note, however, that it is not intended that the invention be limited to the example presented herein. It is appreciated that one skilled in the art would be able to apply the principles of the invention to other communications systems (wireless or not) as well.

Paragraph beginning on page 11, line 20

A13

~~The~~ In the transmit direction, the signal processing portion 26 functions to protect the data so as to provide reliable communications over the channel. Several processes performed by channel coding block 44 are used to protect the data including cyclic redundancy check (CRC), convolutional coding and interleaving. The resultant data is assembled into bursts whereby guard and ~~trail~~ tail bits are added in addition to a training sequence midamble that is added to the middle of the burst. Note that both the user data (i.e. voice data) and the signaling information go through similar processing. The assembled burst is then differentially encoded and modulated by a Gaussian Minimum Shift Keying (GMSK) modulator 46.

Paragraph beginning on page 11, line 28

A14

In the receive direction, the output of the baseband codec is demodulated using GMSK demodulator 56. Several processes performed by channel decoding block 26 are then applied to the demodulated output. The ~~processed~~ processes performed include equalization, burst disassembly, de-interleaving, convolutional decoding and CRC.

Paragraph beginning on page 12, line 6

A15

In addition, the mobile station performs other functions that may be considered higher level such as synchronization, frequency and time acquisition and tracking, monitoring, measurements of received signal strength and control of the radio. ~~Other~~ <u>Additional</u> functions include handling the user interface, signaling between the mobile station and the network, the SIM interface, etc.

Paragraph beginning on page 12, line 18

A16

In operation, coded transmit data bits $d(k)$ 72 together with training sequence bits $f(k)$ 76 and tail bits are assembled into bursts of 142 bits by burst assembler 74. Each bit period T has a duration of approximately 3.7 microseconds. The data is differentially encoded by encoder 78 before being modulated using Gaussian Minimum Shift Keying (GMSK) modulation by modulator 80. The modulated signal is input the RF transmitter 81 and output onto the wireless channel 82 which is represented by ~~he(ô, t)~~ $h_c(\tau, t)$. Additive Gaussian noise is represented as noise sequence $n(k)$ 84 which corrupts each received burst and is modeled by adder 86. The resultant composite signal is downconverted by the RF receiver circuitry 87 and input to the GMSK demodulator 88.

Paragraph beginning on page 13, line 9

A17

The output of the demodulator 88 is sampled by sampler 90 at a rate 1/T so as to generate a stream of samples $y(k)$. The samples making up the burst are then disassembled by burst diassembler 92 which functions to split the received samples into a data portion <u>and</u> a training sequence portion. The data portion 93 is input to the maximum likelihood sequence estimator (MLSE) 94 while the training sequence portion is input to the channel estimation block 96. A training sequence $f(k)$ 98 stored in memory is also input to the channel estimation as a reference sequence. The estimate of the channel $h(k)$ 99 is then input to the MLSE 94.

Paragraph beginning on page 13, line 30

A18

The so called channel estimate, however, requires knowledge of the channel order. Thus, before a channel estimate can be performed, the order of the channel (i.e. number of taps of the impulse response function used to model the channel) must be selected. The present invention provides such a method. The method of the present invention is operative to determine the number of channel taps in the FIR filter used to model the channel and <u>to determine</u> their ~~value~~ <u>respective values</u>.

Paragraph beginning on page 14, line 5

A19 cont

A block diagram illustrating a channel estimator constructed in accordance with the present invention shown in Figure 5. The channel estimator, generally referenced 110, is preferably

implemented in the channel estimation block 96 (Figure 4). Note, however, that the channel order selection method and apparatus of the present invention is not limited to the example ~~present~~ presented herein and may be implemented by one skilled in the signal processing arts ~~to~~ in other types of communication systems (wired or wireless) as well. In addition, the method and apparatus presented herein may be implemented using any suitable technique known in the art such as (1) software or firmware running on a digital signal processor (DSP), (2) software or firmware running on a general purpose microprocessor or CPU or (3) as hardware circuitry ~~on~~ in an ASIC, FPGA, custom integrated circuit, etc.

A19 Concl

Paragraph beginning on page 14, line 21

A20

$v(k)$ represents white, zero ~~means~~ mean, complex Gaussian noise;

Paragraph beginning on page 16, line 6

A21

The average energy of the channel taps 122 is calculated by the addition (using adder 120) of the previous average energy calculation multiplied by a leakage factor α (using multiplier 128) with the current taps' average energy as it appears at the output of block 118. The averaged tap energy appears at the output of adder 120.

Paragraph beginning on page 17, line 3

A22

A flow diagram illustrating the channel estimation method of the present invention is shown in Figure 6. As described previously, the method assumes that the channel has at most L taps and a time spreading of up to M symbols (step 140). An initial channel estimate is then performed assuming an M-tap long channel impulse response (step 142). The initial channel estimate may be performed using any suitable linear method such as a least squares technique, correlation method, etc. Note that L is less than M so as to ensure that the actual channel taps will be contained in the M estimated taps thus making certain that the equalizer will effectively eliminate intersymbol interference. The channel estimate is performed during each burst using the training sequence transmitted in the middle of the burst and the stored reference training sequence.

Paragraph beginning on page 17, line 13

A23

The energy contained in the estimated channel taps is then calculated (step 144) and then averaged with leakage (step 146). Averaging with leakage serves to track slow variations in the pattern of resultant channel taps. In addition, averaging of the energy (as opposed to amplitude) is preferable since the average of the amplitudes of the channel taps is zero. This is due to the fact the channel taps are represented as zero-mean, complex, Gaussian random ~~process~~ processes.

In the ABSTRACT

A24

A novel and useful apparatus for and method of determining the channel order and channel estimate in a communications system such as a wireless communication system including cellular and cordless. ~~These types of~~ Such channels ~~can be~~ are typically characterized by rapidly changing impulse response and their taps can be modeled as zero-mean, complex, Gaussian random processes. A sufficiently long, initial channel estimate of length is performed so as to ensure that the actual channel taps will be contained in the estimated taps thus making certain that the equalizer will effectively eliminate intersymbol interference. ~~The channel estimate~~ Channel estimation is performed ~~during~~ each burst using the training sequence transmitted in the middle of the burst. The tap energies are ~~then~~ averaged so as to track slow variations in the pattern of resultant channel taps. ~~The~~ A noise floor is ~~thus~~ calculated using the lowest averaged taps~~. A~~ and a threshold is computed based thereon and applied to the average taps. The channel order and the tap positions are then selected in accordance ~~with the~~ those average taps that are above the threshold.